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PATC Course: HPC-based simulations, Engineering and Environment

Registration for this course is available here
All PATC Courses at BSC do not charge fees.
PLEASE BRING YOUR OWN LAPTOP.

DATE:
Tuesday, 16 February, 2016 - 09:00 to Thursday, 18 February, 2016 - 18:00

OBJECTIVES:
The objetive of this course is to give a panorama on the use of hpc-based computational mechanics in Engineering and Environment through the projects BSC are carrying on. This panorama includes the basics of what is behind the main tools: computational mechanics and parallelization.

AGENDA:

Day 1

9.00 - 13.00: Introduction to Computational Mechanics:
Mariano Vázquez
What is behind a simulation code? Main concepts. The Physical system and its Mathematical description
Discretization: divide and conquer Discretization: algorithms and codes

14.00 - 16.00:Parallel algorithms for Computational Mechanics:
Guillaume Houzeaux
What is parallelization in a simulation code? Paradigms and scenarios.
Description of parallelization schemes. Parallel algebraic solvers and solving strategies.

16.00 - 18.00: Computational Fluid Dynamics (CFD): driving and sailing:
Herbert Owen
CFD is one of the fields of Computational Mechanics where HPC and parallelization is more influential, due to the Physical complexity of the systems. This talk describes incompressible flow applications in automotive industry and yacht design. The Physical description includes turbulence modelling, free surface and floating rigid bodies.

Day 2

9.00 - 11.00: Introduction to Computational Solid Mechanics
Eva Casoni
This talk provides knowledge in all the technical aspects of Solid Mechanics analyses, which are in high demand in many industries.
Solid mechanicians focus on the deformation and failure of materials with a defined rest shape for real-world applications. A solid mechanician envision the final application and uses theoretical, experimental, numerical and computational tools to solve the problem.
A general view of the most used and useful approaches and constitutive theories applicable to the deformation and fracture of metals, composite and biological materials will be done in this talk, covering the general aspects of the modelling and solution approach.

11.00 - 13.00: Introduction to mesh generation for simulation
Xevi Roca
This course is a brief introduction to fundamental mesh generation approaches used in academic and commercial simulation.

Mesh generation methods have succeeded in decomposing highly complicated domains by filling them with distributions of different types of elements such as triangles, quadrilaterals, hexahedra, tetrahedra, pyramids, and prisms. These meshing methods are used in a daily basis by computational engineers and scientists to obtain numerical predictions over complex geometrical configurations. The course introduces different types of: geometrical representations, meshing methods, element types, boundary approximations, quality measures, sizing approaches, and software packages. This is an introductory course intended to facilitate the election of the proper mesh generation methods for simulation.

14.00 - 16.00: N-bodies Contact Detection and Resolution
Cristóbal Samaniego
The talk is divided in two main subjects:
First, the contact detection algorithm prevents interpenetration between bodies by estimating the time of collision. The algorithm includes efficient search methods to drastically reduce the number of operations when we estimate the time of collision between a pair of bodies.
Second, the contact resolution algorithm changes the velocity of the bodies in contact in order to prevent interpenetrations. This subject also includes methods to reduce the execution time. Also, other aspects of the n-bodies contact are described to improve and to have a more robust method to solve the interaction between rigid solids.

16.00 - 18.00: Introduction to numerical combustion
Daniel Mira
The energy market is leading towards cleaner solutions in order to reduce pollutant emissions from combustion systems. Nowadays, numerical simulations have become an important tool to provide insight into the dynamics of flames as well as the overall performance of the entire combustion device. In particular, turbulent combustion is a complex phenomenon involving the interaction of chemical reactions and heat release with turbulent flow structures. This interaction leads to the development of a wide range of time and length scales, coupled to hundreds of species and reactions, so the requirements in HPC are an essential aspect to address this problem.
This session addresses some fundamental aspects of combustion modelling with emphasis on HPC and practical examples of gas turbines.

Day 3

9.00 - 11.00: Scientific visualization
Luz Calvo
The visual representation of scientific data has been a key component of science, advancing thanks to it or directly causing advances. Nowadays, the field of scientific visualization is growing fast, thanks to the technological explosion and a renewed interest of society in design and aesthetics. In this course we will survey the field of data visual representation, discuss about available tools, and touch on narrative topics that researchers can learn on their own to improve their graphical communication skills. We will explore elements of computer graphics, human-computer interaction, perceptual psychology and design in addition to data integrity to learn how to present this data to an observer in a way that yields insight and understanding.

11.00 - 13.00:Biomechanics: Cardiac Computational Modelling
Jazmin Aguado-Sierra & Mariano Vázquez
From an engineering point of view, Biological systems are amongst the most complex Physical systems in Nature. Multiscale, multiphysics, great variability, large uncertainties, numerical issues, validation difficulties and extremely complex mathematical models are amongst the common features of computational biomechanics. Considering that all these problems usually show up altogether, the use of HPC-based simulations in biomechanics is a must.
In the BSC's CASE department, we focus in simulations at organ level. The "Alya Red Cardiac Computational Model" is a paradigmatic example, which will be deeply described in the talk.

14.00 - 15.00: HPC Challenges in the Oil Industry
Mauricio Hanzich, Josep de la Puente
An introduction to the numerical methods involved in the modelling, migration and inversion of seismic and EM data for hydrocarbon exploration. Talk will include: why the geophysical exploration matters, what are the main challenges today and the future trends and how HPC is mandatory for many geophysical problems.
From methods and algorithms for geophysical exploration to HPC software on modern architectures. Talk will include: main issues to be tackled for HPC applications for Oil Industry, current programming models and paradigms for such applications and current state of HPC environments and future trends.

15.00 - 16.00: Supercomputing for fusion energy applications
Xavier Saez

Future energy requirements set an unprecedented challenge for our society. Fusion energy is uniquely placed to meet the growing energy demand. In this talk illustrative examples of computer modeling in the fusion energy field are discussed, with special emphasis in applications requiring supercomputing resources.

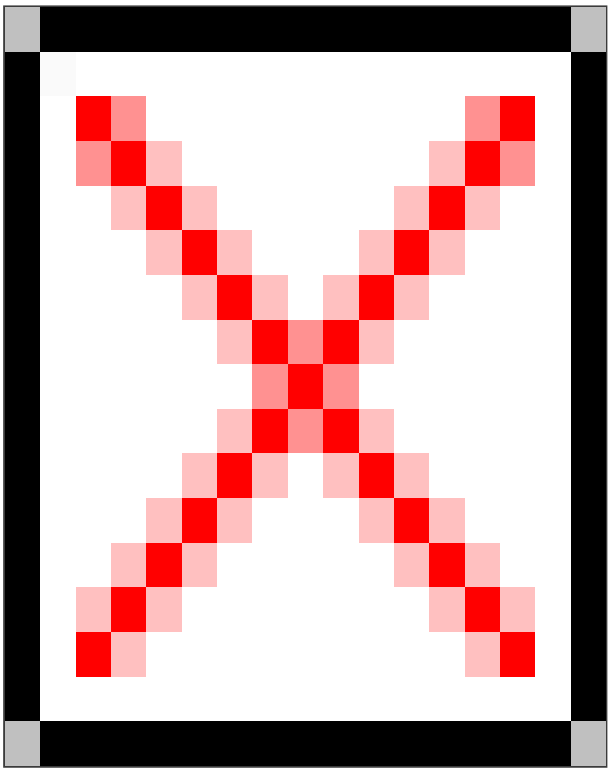
16.00 - 17.00: Atmospheric transport modelling & High-resolution meteorological modelling using CFD
Matías Ávila, Arnau Folch
Example case 1: volcanic ash dispersal and civil aviation - Atmospheric transport models are used to simulate the dispersal of any substance in the atmosphere. Applications include dispersal of pollutants or air quality modelling, among several others. In paricular we focuss on volcanic ash dispersal and its impacts on civil aviation.
Example case: assessment of wind energy resources - CFD is the pivotal tool to increase the spatial resolution of mesoscale Numerical Weather Prediction Models. This talk describes how turbulent CFD models are used to assess winds and turbulence in the microscale, focussing on the evaluation of the wind resource for eolic energy.

17.00 - 18.00: HPC and fluid-structure interaction
Juan Carlos Cajas, Beatriz Eguzkitza
We present a general coupling strategy for multi-physics problems. The basic idea is to have independent codes, one for each physical problem, and communicate the coupling variables using MPI. Special interest on Fluid Structure Interaction (FSI) problems. Usually, the multi-physics problems involve different space and time scales, which can lead to situations in which optimized algorithms for the individual problems are useless in the coupled one. Thus, different coupling algorithms and relaxation schemes are considered and tested. Cases for FSI problems in wind generation and bio-mechanics are considered.

REGISTRATION:
Registration

TARGET GROUP:
Level: *(All courses are designed for specialists with at least 1st cycle degree or similar background experience)*
INTERMEDIATE: for trainees with some theoretical and practical knowledge;

VENUE:



The course will take place in Barcelona Supercomputing Centre, within the UPC Campus Nord premises

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Room VX208, Vertex building

HOW TO ARRIVE?:

From the Airport

Barcelona airport is at 12 Km from the city. More information about Barcelona's airport: www.aena.es. You can arrive with different transport methods from the airport to BSC:

By taxi

In T1, you will find a taxi stand in the arrivals zone (P0) and in the Barcelona-Madrid air corridor; in T2, opposite terminals T2A, T2B and T2C. If they are available, they will show a green light with the text LIBRE or LLIURE (it means "available"). You can check fees at www.taxibarcelona.cat.

By car

If you rent a car from the airport (T1), please leave "El Prat del Llobregat" and take C-32B. Continue along this route and head towards Ronda de Dalt / Lleida / Girona. Close to Barcelona, take route C-32 passing close to Cornellà del Llobregat and L'Hospitalet. Take B-20 and take Exit 10 called "Carretera d'Esplugues". Take the street called "carrer del Gran Capità" and turn left towards Jordi Girona street.

By train

There is a Renfe suburban train. The airport station is situated opposite of terminal T2, and is connected to this terminal via an airbridge. There is also a Bus transit service between the Rail station and T1. From the airport to Barcelona Sants there is approximately 20 minutes journey. From this station, take the L3 (green line) in direction to "Zona Universitaria" and get off on the "Palau Reial" stop. You will have a 5-minutes walking distance to arrive to BSC. (www.renfe.es)

By Bus (Aerobus)

Airport stops: Bus stops at Terminal T1 and T2 (A, B, C)
Downtown stops: This line ends at Plaça Catalunya (city center). Once there, you may take L3 of the underground to "Palau Reial" or "Zona Universitaria" stations.

From the City Centre

Campus Nord of Universitat Politècnica de Catalunya is located at the North-West corner of the city, at the end of the Green Line (L3) of the underground. In order to reach the Campus by public transport, it is advisable to use the underground. There are two stations near to the Campus, "Zona Universitària" and "Palau Reial", both on L3.

COMMENTS:

Please fill in the **evaluation form** by following**the link.**

COST:

There is no registration fee. The attendees would need to cover the expenses for travel, accommodation and meals.

MATERIALS:

INTELLECTUAL PROPERTY RIGHTS NOTICE:

RECOMMENDED ACCOMODATION:

Please follow the link for map of some local hotels.

CONTACT US:

CONTACT US for further details about MSc, PhD, Post Doc studies, exchanges and collaboration in education and training with BSC.
For further details about Postgraduate Studies in UPC - Barcelona School of Informatics (FiB), visit the website.

SPONSORS:

BSC and PRACE 3IP project are funding the PATC @ BSC training events.
If you want to learn more about PRACE Project, visit the website.